Tourism Management 46 (2015) 408–418

Contents lists available at ScienceDirect

Tourism Management

journal homepage: www.elsevier.com/locate/tourman

Current issue in tourism

Lyme disease: Current issues, implications, and recommendations for tourism management

Holly Donohoe*, Lori Pennington-Gray, Oghenekaro Omodior

Department of Tourism, Recreation and Sport Management, University of Florida, USA

HIGHLIGHTS

- Lyme disease is an emerging infectious disease that has implications for tourism.
- Exposure, knowledge and beliefs, and personal protection behaviours are risk factors for infection.
- Tourism management stakeholders should liaise with health authorities to mitigate impacts.

ARTICLE INFO

Article history:
Received 5 August 2013
Accepted 5 July 2014
Available online 20 August 2014

Keywords:
Health risk
Infectious disease
Lyme disease
Ticks

ABSTRACT

Lyme disease is a bacterial infection spread through the bite of an infected tick. In the last few decades, the number and spatial reach of new cases has increased globally and in the United States, Lyme disease is now the most commonly reported vector-borne disease. Despite this evolving public health crisis, there has been little-to-no discussion of the implications for tourism supply and demand. This paper reviews the scientific literature to identify Lyme disease risk factors and the implications for tourism management are discussed. The major contribution of this paper is a set of recommendations for tourism managers who may be tasked with mitigating the risks for visitors and employees as well as the potential impacts of Lyme disease on destination sustainability.

1. Introduction

Lyme disease is the world's fastest growing vector-borne zoonotic disease with cases reported in over 60 countries and endemic foci in North America, Europe, and Asia (WHO, 2013). The World Health Organization (WHO, 2013) reports that the risk is generally low except for those travelling to rural areas, particularly campers, hikers, and workers in countries or areas at risk. However, this assessment may give a false sense of security for people working or travelling in areas where the risk of Lyme disease is uncertain and it may breed complacency amongst those responsible for occupational, travel, or public health.

The northeastern United States is traditionally defined as the endemic global center for Lyme disease and the public health risk is highest in this area. In 1982, systematic surveillance for Lyme disease was initiated by the U.S. Centers for Disease Control and Prevention (CDC, 2013a), with 11 states reporting 491 cases. In 1990 a standardized case definition was approved and by 2012, the number of cases reported had increased over 200 percent (CDC, 2013b; Ciesielski et al., 1989). The CDC (2013a) states that only 10 percent of Lyme disease cases are being recorded which translates into approximately 300,000 estimated cases in the United States each year (Fig. 1). A majority (95 percent) have been concentrated in the northeast, yet cases have been reported in every state and in many countries around the world and their geospatial analysis reveals that Lyme disease has extended well beyond traditionally defined endemic areas (CDC, 2013b; Diuk-Wasser et al., 2012). Lyme disease case rates have been increasing exponentially at the global scale while in the United States it has become the number one and most medically significant vector-borne infectious disease (Abbott, 2006; Piesman & Eisen, 2008). While it is possible to surmise that better diagnostics and increased reporting are responsible for case rate trends in the United States and other parts of the world, case rates vary because of social, environmental, and economic variables such as climate and ecological change, tick and host species range expansion, human demographics and behaviour, land use patterns, clinical practice, disease reporting standards, surveillance technologies, and true incidence (Daniels, Falco, Schwartz, Varde, & Robbins, 1997; Grenfell & Harwood, 1997; Horowitz et al., 2013).

* Corresponding author. Department of Tourism, Recreation and Sport Management, University of Florida, PO Box 118208, Gainesville, FL 32611-8208, USA.
E-mail address: hdonohoe@hhp.ufl.edu (H. Donohoe).

http://dx.doi.org/10.1016/j.tourman.2014.07.006
0261-5177/

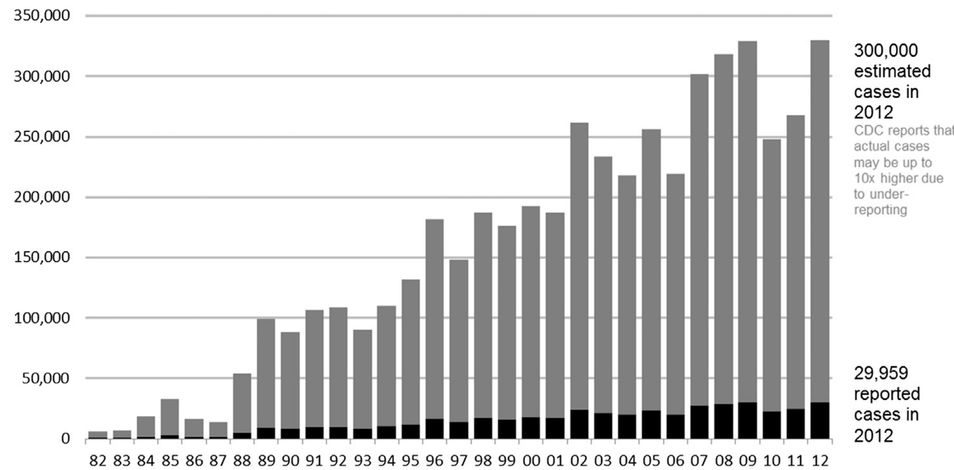

Fig. 1. Annual Lyme disease cases in the United States 1982–2012.

Lyme disease is caused by *Borrelia burgdoferi* – a bacterial pathogen transmitted to humans through the bite of an infected tick. The pathogen is sylvatic; meaning that it cycles between wild animal hosts and vectors. Humans are not the primary host and as such are usually incidental or dead-end hosts. Although the symptoms have been observed since the 19th century, it has only been 30 or so years since the etiological agent and the primary vector(s) for Lyme disease were recognized and their medical significance reported. The infection is characterized by a distinctive bull's eye rash that occurs in 60–80 percent of patients (CDC, 2011). From the early symptoms of fever, headache, muscle and joint pain to the more serious symptoms such as cognitive impairment, cardiac abnormalities, arthritis, and paralysis, the impacts on individual health are noteworthy (WHO, 2012). Diagnosis is completed through a clinical examination and confirmed through serological tests and treatment consists of oral or intravenous antibiotics. Currently, there is no vaccine available for human use but several are available for veterinary use (Willadsen, 2006).

Although the medical and scientific communities have been pursuing the problem for years, tourism has been slow to recognize that Lyme disease can affect both tourism supply and demand. In the supply context, outdoor workers in endemic areas are at increased risk because of their frequent exposure to ticks and tick habitat (Piacentino & Schwartz, 2002). Antecedent studies have established that outdoor workers are up to 10 times more likely to be infected than the general population (Bowen, Schulze, Hayne, & Parkin, 1984; Smith et al., 1988). Given that a proportion of individuals employed in the tourism, parks, and outdoor recreation sectors are required to spend some to all of their time working outdoors, the potential threat to individual and industry health is cause for concern. For those infected, days to weeks of sick time may be required to complete treatment and the medical costs can be significant. In addition to the social costs, the U.S. Department of Labor reports that workplace illnesses have a major impact on an employer's economic sustainability and profit margin. The annual number of nonfatal illnesses has been estimated at 430,000 with direct cost of $12 billion and indirect costs of approximately $100 billion (Leigh, 2011). Direct costs include workers' compensation payments, and it is estimated that employers pay $1 billion per week for direct workers' compensation costs (U.S. Department of Labor, 2014). Workers' compensation covers less than 25 percent of these costs, so all members of society share the economic burden. Indirect costs include but are not limited to training replacement employees, implementation of corrective measures, lost productivity, and costs associated with lower employee morale and absenteeism. The direct medical costs associated with Lyme disease in the United States are estimated at 2.5 billion dollars annually but the true cost of Lyme disease is the profound impacts on personal health and well-being (Maes, Lecomte, & Ray, 1999; Magnarelli, 2009; Zhang et al., 2006).

From a demand perspective, the WHO reports that the risk to those travelling to endemic areas of the world is generally low but nonetheless, they warn travellers to avoid tick-infested areas and tick exposure on their dedicated Lyme disease webpage for international travellers (http://www.who.int/ith/diseases/lyme/en). When outdoor activities are planned during a trip to an endemic area for tick-borne disease, a tourist is at risk and the WHO's assessment can be misleading (Falco & Fish, 1989; Hayes, 2010; Raoult et al., 2001; Smith et al., 1988). Their risk can be magnified because tourists may not have all of the necessary information or access to resources that would enable them to make informed decisions regarding Lyme disease prevention before and during travel (Jonas, Mansfeld, Paz, & Potasman, 2011; Kelly-Hope, Purdie, & Kay, 2002). For tourists who are aware of health risks before choosing a destination, Sönmez and Graefe (1998) and Kozak, Crotts, and Law (2007) report that perceived risk can be a strong predictor for avoiding certain regions or changing travel plans. Dixon et al. (2010) report that the macroeconomic consequences of a health threat or crisis are highly sensitive to demand-side effects such as the reductions in international tourism and leisure activities that result from elevated risk perceptions. For example, during the severe acute respiratory syndrome (SARS) pandemic, traveller's health risk perceptions had a significant effect on international tourism demand. Over 8000 cases and 774 deaths in 26 countries were reported in 2003 with a majority of cases occurring in Asia (WHO, 2004). The initial spread of SARS was exponential with predictive models showing that if uncontrolled, a majority of people would become infected wherever it was introduced (Dye, 2003). Air travel to areas affected by the advisories decreased dramatically during the epidemic (Kuo, Chen, Tseng, Ju, & Huang, 2008; Zeng, Carter, & De Lacy, 2005). In East Asia, tourist arrivals dropped by 41 percent during the month of April compared to the same period in 2002, with China, Hong Kong, Singapore, and Vietnam reporting the greatest losses (Pine & McKercher, 2004; Wilder-Smith, 2006). Growth of the broader travel and tourism economy, which measures visitor spending and capital investment around the world, slowed to 2.9 percent down from 5 percent in previous years and international arrivals fells 1.2 percent (World

Travel and Tourism Council, 2003). While Lyme disease is certainly not a pandemic and it cannot be spread person to person, like SARS and other infectious disease risks, it can prompt fear and anxiety that most certainly can affect a traveller's perceptions and by extension; it can affect their travel choices and behaviours (Birnbrauer, Pennington-Gray, & Donohoe, 2013).

Herrington's (2004) national survey of American risk perceptions regarding ticks and Lyme disease found perceived risk to be a predictor of behavioural change. Those who had seen ticks, had heard about Lyme disease, were concerned about being bitten, or knew someone who had Lyme disease were more likely to engage in tick-bite prevention such as avoiding tick habitat and wearing insect repellent. Brewer et al.'s (2004) research confirms that higher risk judgements encourage people to engage in protective behaviour, indicating a causal relationship between perceived risk and behaviour modification. Although empirical research has yet to confirm as much, Lyme disease beliefs and attitudes have likely been having an impact on the decision-making processes and behaviours of outdoor workers, recreationists and travellers (Hanson & Edelman, 2003). Knowing that Lyme disease poses a real and growing threat to the tourism industry, the purpose of this paper is to first, review the scientific literature to identify Lyme disease risk factors and second, to critically assess the implications for tourism management.

2. Literature review

A search for scholarly journal articles about Lyme disease was performed using PubMed, ProQuest Global, and Google Scholar on July 6, 2013. The search parameters were narrowed to identify articles where “Lyme disease” occurred in the title then additional words were added to winnow down the results to relevant articles: “travel”, “tourism”, “recreation(al)”, “park(s)”, “occupation(al)”, “risk”, and “prevention” (Table 1). No temporal restrictions were used. After removing duplicates, 132 unique scholarly articles were identified and reviewed.

The search for articles with “Lyme disease” and “travel” or “tourism” resulted in 0 articles in all three search engines. The fact that Lyme disease has not been examined in the context of tourism and travel is no surprise because the tourism domain has not traditionally focused the research lens on health risks. There is a research and knowledge gap regarding health risk generally and Lyme disease specifically, as well as their potential and real impacts on the tourism industry. It should be noted that a similar PubMed search using “tick-borne disease” and “tourism” yielded 15 papers dealing with other tick-borne diseases that occur independent of or in conjunction with Lyme disease. *Anaplasma*, *Babesia*, *Bartonella*, *Ehrlichia*, and *Rickettsia* for example, may be just as significant as Lyme disease in some parts of the world yet they are equally underappreciated in the travel and tourism context. These papers were consulted in the preparation of this paper and they are also included in the analysis that follows.

When “recreation/al” and “parks” was added to the search, 7 articles were identified, 5 of which were case or exploratory studies of *Ixodes scapularis* tick populations and their hosts in select recreational parks in Canada (Morshed, Scott, Fernando, Mann, & Durden, 2003; Scott et al., 2008), Italy (Curioni et al., 2004), and the United States (Daniels et al., 1997; Falco & Fish, 1989; Lane et al., 2006). Two articles surveyed parks visitors (Hallman, Weinstein, Kadakia, & Chess, 1995) and recreational destination workers (Rees & Axford, 1994) about their Lyme disease knowledge, tick-exposure, tick-bite prevention behaviours and/or clinical history with the disease. Of the 13 articles where “occupation(al)” or “work(er)” appeared, the majority were seroprevalence studies of individuals working in the forestry, parks, land management, and agricultural sectors in various locations around the world (e.g. Cisak, Wójcik-Fatla, Zając, Sroka, & Dutkiewicz, 2012; Goldstein et al., 1990; Guy, Bateman, Martyn, Heckels, & Lawton, 1989; Nakama, Muramatsu, Uchikawa, & Yamagishi, 1994; Smith et al., 1988; Stanchi & Balague, 1993). One study from the United States reported the results of a survey of workers regarding their knowledge of Lyme disease and their behaviour regarding tick-bite prevention (Schwartz & Goldstein, 1990) and one article provided a comprehensive review of the occupational risks (Piacentino & Schwartz, 2002). Over 60 articles were found that contained “Lyme disease” and “risk” in the title. A majority of these articles assumed a natural science perspective (i.e. epidemiology, medicine, microbiology, and zoology) and reported on the spatial and temporal factors affecting ticks, the causative agent – the Borrelia pathogen(s), host species, environment, and human exposure (e.g. Allan, Keesing, & Ostfield, 2003; Glass et al., 1995; Guerra et al., 2002; Maher, Nicholson, Donnelly, & Matyas, 1996; Ogden et al., 2008). A minority of the papers focused on behavioural risks and a review of these papers revealed a consensus that human exposure to ticks is the central risk factor for infection (e.g. Diuk-Wasser et al., 2012; Fish, 1995) while knowledge and prevention act as risk mediators (e.g. McKenna, Faustini, Nowakowski, & Wormser, 2004; Smith, Wileyto, Hopkins, Cherry, & Maher, 2001). Articles that contained the key word “prevention” did so primarily as a recommendation for public agencies responsible for reducing the burden of infection. Piesman and Eisen (2008) and Poland (2001) provide a review of Lyme and tick-borne disease prevention strategies and Mowbray, Amlôt, and &Rubin (2012) provide a review of education and communication interventions to prevent tick-borne disease. A critical synthesis of this body of research was completed to identify Lyme disease risk factors as they have potential implications for tourism management. It is the aforementioned factors – exposure, knowledge, and personal protection behaviour - that comprise the discussion in the sections that follow.

Table 1
Journal article search results.

Lyme disease	PUBMED	ProQuest global	Google scholar	Total (duplicates removed)
	3524	5095	3840	
AND				
Tourism	0	0	0	0
Travel	0	0	0	0
Recreation(al)	1	3	4	4
Park(s)	2	7	4	7
Occupation(al)	1	3	3	3
Work(er)	1	12	12	12
Risk(s)	26	57	68	68
Prevention	3	57	82	82
Total (duplicates removed)				132

*Google results include articles only, no citations or patents.

3. Results

3.1. Tick exposure

I. scapularis or the blacklegged tick is the primary vector for Lyme disease in the United States. In the United States and other areas of the world, dozens of tick species have been implicated in the spread of Lyme and Lyme-like *Borrelia* pathogens to humans and animals (e.g. Barbour, Maupin, Teltow, Carter, & Piesman, 1996; Burgdorfer, 1984; Clark, 2004; Clark, Leydet, & Hartman, 2013; Harrison et al., 2010; Mather & Mather, 1990; Nakao, Miyamoto, & Fukunaga, 1994; Piesman & Sinsky, 1988; Piesman, Clark, Dolan, Happ, & Burkot, 1999). Epidemiological studies have explored the relationship between ticks, climate, seasonality, host species, and disease risk in a variety of local or regional contexts (e.g. Estrada-Peña, 2003; Šumilo et al., 2008; Wielinga et al., 2006). Predictive models have been developed using remote sensing, satellite imagery, geographical information systems, and advanced statistical analysis (e.g. Daniels et al., 1997; Diuk-Wasser et al., 2012; Werden et al., 2014). The research indicates that vegetation and climate are the two central predictors of suitable/unsuitable habitats for tick species and it is therefore possible to identify high-risk areas and potential emergent areas for Lyme disease. The areas with the highest risk for human exposure are those that contain suitable tick habitat, ticks capable of transmitting the Lyme disease pathogen, and have high host activity (Gray et al., 1998; Schulze, Jordan, & Hung, 1995).

Empirical approaches have laid the groundwork for a better understanding of the relationship between environmental factors and tick distribution. However, they fail to account for the vital role that human behaviour plays in the disease transmission process. The global increase in interaction between humans and wildlife through population growth, economic development, and an increasingly mobile society that brings people into endemic areas for work and leisure is amplifying personal risk (Kollaritsch et al., 2011; Quine et al., 2011; Rizzolli, Hauffe, Vourc'h, Neteler, & Rosa, 2011). The rapid expansion of the tourism industry and air travel is of concern as the importation of pathogens and vectors by travellers (purposefully or not) and specifically ticks and tick-borne disease pathogens is a real threat to human and ecological health (e.g. Daugschies, 2001; Hall, 2006; Holzer, 2005; Schuster et al., 2008).

European case reports demonstrate statistical relationships between outdoor recreation in tick-infested forests and tick-borne disease infection (e.g. Daniel, Danielová, Kříž, Jirsa, & Nožička, 2003; Kahl & Radda, 1988; Šumilo et al., 2008). Early case studies in the United States failed to show a significant increase in risk associated with outdoor recreation (e.g. Bowen et al., 1984; Ciesielski et al., 1989; Falco & Fish, 1989) but Smith et al.'s (1988) research found that persons who had spent more than 30 h per week in outdoor activities in endemic areas were 2.5 times more likely to test positive for Lyme disease. Since the 1980s, a small body of literature has evaluated the occupational risk for Lyme disease. In New York, Schwartz and Goldstein et al. (1990) confirmed that Lyme disease is a hazard of outdoor work and a study in New Jersey found that outdoor workers were nearly five times more likely to have contracted Lyme disease than indoor workers (Bowen et al., 1984). In the broader international and tick-borne disease contexts, the research shows similar relationships between tick exposure and infection. In Lithuania, Motiejunas, Bunikis, Barbour, & Sadziene (1994) report that those at highest risk for a tick-borne disease (established through seropositivity testing) are outdoor workers (32 percent tested positive/$N = 6187$). Recent case studies in Europe (e.g. Bartosik, Sitarz, Szymańska, & Buczek, 2011; Bochnickova & Szilagyiova, 2011; Franke, Hildebrandt, Meier, Straube, & Dorn, 2011; Jameson & Medlock, 2011) confirm that ticks, Lyme and other tick-borne disease pathogens are common across Europe and they pose a significant occupational risk to outdoor workers. Two studies in Poland involving serological testing of both ticks and humans confirmed that those who perform work in forest environments are regularly exposed to tick-borne disease pathogens and as such, are at a higher risk of infection. Two Dutch studies of Lyme disease seroprevalence in outdoor workers showed a statistically significant risk (OR, 3.7; 95 percent CI, 1.5–9.7 and OR, 15.0; 95 percent CI, 5.5–42.0) relative to the control group (Kuiper et al., 1991; van Charante, Groen, Mulder, Rijpkema, & Osterhaus, 1998). In 2002, Piacentino and Schwartz published a meta-analysis of articles on the occupational risk of Lyme disease and report that the scientific evidence demonstrates that those who work outdoors in endemic areas are at an increased risk for contracting Lyme disease because of their exposure to ticks. It is evident in this body of literature that exposure to ticks is the single most significant human risk factor and the first line of defence against tick bites should be avoidance of these areas completely or seasonally (during periods of high tick activity), or where appropriate, control of the tick population. Given the geospatial expansion of tick species, increasing human mobility and encroachment into tick habitat, and the attendant expectation that future interactions between humans and ticks are likely to increase, vigilance and on-going monitoring is required as new and extant tick-borne pathogens pose potential threats to public health.

3.2. Lyme disease knowledge

Lyme disease risk is magnified when individuals are not aware of the risks, do not mitigate risks, are not familiar with infection signs and symptoms, and do not know where to seek information or support (Daltroy et al., 2007; Schwartz & Goldstein, 1990). It is widely accepted that knowledge plays an important role in mediating Lyme disease risk as it is a pivotal precursor to preventative behaviour (Piacentino & Schwartz, 2002; Poland, 2001). Herrington's (2004) national survey found that a majority of Americans know about ticks and the risks they present to human health. In the tourism and recreation context, Hallman et al. (1995) found that over 80 percent of people surveyed at three state parks in New Jersey reported knowing about Lyme disease and could name at least one bite prevention strategy (Table 2). In recreational and agricultural settings in Poland, Bartosik et al. (2011) found that workers do not know about the health risks associated with ticks and they are not protecting themselves against tick bites while at work. In the forestry sector, Cisak et al. (2012) found that workers possess only basic tick-borne disease knowledge. In France, a study of nearly 3000 outdoor workers revealed that a majority would like to have access to educational materials so that they can make

Table 2
Personal protection recommendations for preventing Lyme disease.

Avoid tick areas	▪ Become informed of the location of Lyme disease endemic areas and outbreaks ▪ Avoid tick habitat such as wooded and bushy areas with high grass and leaf litter ▪ Take extra precaution in the spring and summer – high season for ticks in temperate regions ▪ Walk in the center of trails and avoid the areas where grass and woods meet ▪ Contact the local health department for more information
Avoid direct contact with ticks	▪ Apply insect repellent with 20 percent DEET to skin ▪ Apply Permethrin to clothing (kills ticks on contact but is not recommended for direct skin application) ▪ Wear long pants, sleeves, socks, and closed-toe shoes ▪ Tuck in clothing ▪ Wear light coloured clothing to make it easier to spot ticks ▪ Use tick medicine or collars on pets
Perform tick checks	▪ Check your body, others, and pets for ticks after being outdoors ▪ Remove ticks before going indoors ▪ Use proper tick removal technique – i.e. wear gloves to avoid tick fluids, grab tick close to the skin with tweezers and pull gently. ▪ Wash your clothing in hot water immediately upon going indoors ▪ Bath or shower in hot water upon going indoors ▪ Seek medical attention if a bite is suspected

Adapted: CDC, 2011.

informed decisions about tick-bite prevention (Thorin et al., 2008). It is difficult to draw conclusions on the basis of the limited study of Lyme and associated tick-borne disease knowledge, but the literature suggests that knowledge varies geographically and although it has not yet been correlated, it may be that knowledge is higher in areas where Lyme and/or other tick-borne diseases are endemic and therefore the risk is higher and investments in educational interventions may be greater.

In the latter case, the science appears more developed and it suggests that educational interventions do influence an individual's Lyme disease knowledge. For example, Gould et al. (2008) evaluated resident behaviours following an intensive community-wide education program and found that 99 percent were aware of the risks and were taking steps to prevent tick exposure. Gray et al. (1998) assessed knowledge of Lyme disease among a sample of students before and after an educational intervention and found that general knowledge of ticks and Lyme disease improved. Jenks and Trapasso (2005) found that knowledge of tick removal and the signs and symptoms of infection improved following a one-on-one educational intervention by a physician. Maher et al. (2004) measured the impact of a Lyme disease education program for children in the United States and found that participants had more knowledge of ticks and more confidence in their ability to do a tick check. Fox (2009) reports that individuals were more knowledgeable about wearing protective clothing following an educational intervention while knowledge of other personal protection measures was not significantly changed. This body of work provides empirical evidence that the communication of objective and clear messages about tick-borne disease and tick exposure can be effective for increasing public knowledge as well as an individual's ability to make informed decisions about personal protection. Concomitantly, prevention investments specifically targeted at increasing public knowledge are an important risk mediator because knowledge can empower the individual to choose to engage in personal protection behaviours. Not knowing about Lyme disease is most certainly a risk factor for those living or visiting endemic areas for work or leisure.

3.3. *Personal protection behaviour*

It is widely accepted in the health risk literature that behaviour plays an important role in minimizing disease risk (Goldstein et al., 1990). Behavioural modification related to lifestyle, hygiene, and personal protection is the primary method for the prevention of infectious diseases where prophylactics are unavailable. For example, Noroviruses are the most common cause of epidemic gastroenteritis on cruise ships and they are responsible for at least 50 percent of all gastroenteritis outbreaks worldwide (Goodgame, 2006; Hall et al., 2011). Hand hygiene (washing with soap and water) is the single most important method for preventing infection and controlling transmission (Hall et al., 2011). To prevent mosquito-borne infectious diseases such as Dengue fever and West Nile virus, personal protection through the use of insect repellents and the avoidance of outdoor activity during peak mosquito feeding times is recommended in conjunction with community-based chemical and biological control investments (Renganathan et al., 2003). In the case of Malaria, the use of insecticide-treated bed nets has been shown to minimize human-vector contact and the incidence of infection by up to 50 percent (Choi et al., 1995).

In the absence of a Lyme disease vaccine for human use, the U.S. Centers for Disease Control (2013a) recommends personal protection measures for avoiding tick bites and infection: (1) avoid tick areas; (2) avoid direct contact with ticks; and (3) remove ticks from your body (Table 2). If tick habitats cannot be avoided, there are simple things that individuals can do to minimize the risk for tick bites and pathogen exposure (see Table 2). Wearing protective clothing mechanically decreases direct skin exposure and wearing light-coloured clothing makes it more likely that the tick will be detected and removed before it finds a feeding site (Garcia-Alvarez, Palomar, & Oteo, 2013). Repellents containing DEET (N, N-diethylmeta-toluamide) applied to skin and permethrin-based insecticides applied to clothing have been shown to effectively decrease the risk of tick bites and they are reasonably safe to use (Patey, 2007; Piesman & Eisen, 2008). Recently, Vaughn et al. (2014) evaluated the protective effectiveness of factory-based and long-lasting permethrin (insecticide) treated uniforms among a cohort of outdoor workers in North Carolina. The incidence of work-related tick bites reported by the treatment group was significantly lower than the control group and the treated uniform prevented 95% of tick bites. The results indicate that long-lasting permethrin impregnated uniforms can be highly effective for deterring tick bites for up to one year.

If a tick bite should occur, the tick should be removed using the proper technique of grabbing the tick close to the skin and pulling gently upward with tweezers (tick removal guide: http://www.cdc.gov/ticks/removing_a_tick.html). The tick should be saved in a sealed container and provided to a physician for testing when the victim seeks medical attention (Due, Fox, Medlock, Pietzsch, & Logan, 2013; Garcia-Alvarez et al., 2013). In this regard, knowing the early signs and symptoms of infection are important for early diagnosis and treatment (Symptom guide: http://www.cdc.gov/ticks/symptoms.html). It is important to note that not all bites will result in infection because not all Lyme disease transmission-capable ticks carry the pathogen. And, the public health risk for Lyme disease is affected by spatiotemporal patterns of the tick vector, its life stage, preferred host species (i.e. mice, deer), as well as seasonality, climate, and a range of other environmental factors (Adelson et al., 2004; Diuk-Wasser et al., 2006; Ostfeld et al., 2001; Qui, Dykhuizen, Acosta, & Luft, 2002; Schulze, Jordan, Schulze, Mixson, & Papero, 2005).

It is equally important to note that while numerous personal protection strategies have been recommended by public health authorities (Table 2), they vary in cost, acceptability, and effectiveness, and their uptake has been universally poor (Corapi et al., 2007). Research in areas where Lyme disease is endemic has demonstrated that despite adequate knowledge about its symptoms and transmission, individuals are not taking action to protect themselves from the risk of infection. In the tourism and recreation context for example, Hallman et al. (1995) reported that over 80 percent of visitors surveyed in New Jersey state parks could name at least one tick bite prevention measure but a majority (60 percent) took no precautions. Shadick, Daltroy, Phillips, Liang, & Liang (1997) study of residents and visitors to Martha's Vineyard in Massachusetts found that knowledge about Lyme disease alone was not a predictor for protective behaviours and visitors were less likely to protect themselves than residents. A similar study conducted ten years later found that visitors to Nantucket (located next to Martha's Vineyard) were significantly more likely to take precautions when visiting if they had been exposed to a Lyme disease education program while on the ferry to this island destination (Daltroy et al., 2007). In the United Kingdom, a study of early Lyme disease patients found that participants were more likely to perform tick checks, monitor for symptoms, and seek medical attention after a countryside visit (i.e.) rather than take precautions before and during the potential exposure (Marcu, Barnett, Uzzell, Vasileiou, & Susan, 2013). Those who regularly frequented the countryside were the least likely to perform during-visit precautions (Marcu et al., 2013). Herrington's (2004) national survey of Americans found that despite knowing about Lyme disease risk, a majority (60 percent) of those surveyed were not taking action to prevent tick bites. Conversely, Gould et al.'s (2008) study of knowledge, attitudes, and behaviours of Connecticut residents – a highly endemic area of the United States, found that 84 percent knew some to a lot about Lyme disease, 56 percent felt they were very or somewhat likely to get Lyme disease in the coming year, 99 percent used personal protective behaviours to prevent Lyme disease, and 65 percent reported using environmental tick controls (e.g. pesticide application on personal property).

In the occupational context, "Adherence to National Institute for Occupational Safety and Health-recommended tick bite prevention methods is poor" in the United States and the same is suggested in the literature for other parts of the world (Vaughn et al., 2014: 473). In Poland for example, Cisak et al. (2012) found less than 30 percent of the forestry workers they surveyed were practising tick-bite prevention. Bartosik et al. (2011) found that high-risk workers do not possess knowledge of the potential consequences of a tick bite, are unlikely to take protective measures beyond insect repellent application, and those from urban areas were less likely to protect themselves. The mixed results from the study of residents, visitors, and outdoor workers suggest that a variety of factors are influencing the adoption of personal protection and that more research is needed to better understand how they vary spatially, temporally, socioeconomically, or otherwise (Bayles, Evans, & Allan, 2013).

A limited number of controlled trials have attempted to empirically measure the relationship between knowledge, tick-bite prevention, and seropositivity (laboratory confirmed measure of infection). Daltroy et al. (2007) conducted a randomized trial of a Lyme disease educational program whereby approximately 30,000 visitors to Nantucket - a high-risk area in Massachusetts, were provided with educational materials before arriving. After their visit, study participants reported their tick-bite prevention while in Nantucket and provided a blood sample for serological screening. The study found that visitors who were knowledgeable about Lyme disease were significantly more likely to practice tick-bite prevention during their visit and were also significantly less likely to be infected with Lyme disease during their stay. At 2 months post visit, 144 participants self-reported that they had been infected with Lyme disease and 43 of these were confirmed by physicians. The analysis showed lower rates of self-reported illness among those who received educational materials and long-term visitors (>2 weeks) were more likely to have lower relative risk than short-term visitors. Similarly, Malouin et al. (2003) assessed the impact of a Lyme disease educational campaign in Maryland and found a significant difference between the intervention and non-intervention control group in terms of knowledge and the self-reported use of prevention methods but no significant serological difference between groups was observed. In their study of outdoor workers in New York State, Schwartz and Goldstein (1990) found that when workers were knowledgeable and they practised personal protection, the occupational risk for Lyme disease infection was significantly diminished (as measured by tick exposure odds ratios). A recent study looked at a variety of environmental and behavioural/personal risk factors for seropositivity and found that exposure and age were associated with positive Lyme serology and wearing protective clothing was significantly associated with negative serology (Finch et al., 2014).

This lean body of literature suggests that taking action to prevent tick bites before, during, and after visiting a natural and/or known tick area (see Table 2) can be effective for preventing Lyme disease and that knowledge is a precursor to the adoption of personal protection behaviours (Beaujean, Bults, van Steenbergen, & Voeten, 2013). This finding is congruent with theoretical explanations found in the health education literature. The Health Belief Model was one of the first theories of health behaviour and it remains one of the most widely recognized and applied in the field. The model suggests that an individual's readiness to take action, is influenced by their beliefs about their susceptibility to a health threat, perceptions of the benefits of taking action to prevent it versus the perceived barriers to taking action, and confidence in their ability to take action (self-efficacy) (Rosenstock, 1974). This model has been used to better understand an individual's decision-making and behaviours related to infectious disease risk (e.g. Glanz, Rimer, & Viswanath, 2008; Harrison, Mullen, & Green, 1992; Janz & Becker, 1984) and recently it has been shown to be useful for understanding the grey area between tick-borne disease knowledge and personal protection behaviour (e.g. Bayles et al., 2013; Beaujean, et al., 2013). In the same vein, the theory of planned behaviour posits that behaviour can be deliberative and planned and that an individual's attitude toward a behaviour, the perceived control they have over a behaviour, as well as normative beliefs and subjective norms act to shape an individual's behaviours (Ajzen, 1991, 2002). Theory of reasoned action suggests that a person's behaviour is determined by his/her intention to perform the behaviour and that this intention is, in turn, a function of his/her attitude toward the behaviour and his/her subjective norm (Fishbein & Ajzen, 1975). The difference between these two theories being that the former suggests that attitude and control are predictors of behavioural intention and action while the later suggests behavioural intention is the most important determinant of behaviour (Madden, Ellen, & Ajzen, 1992). While knowledge about a health threat is a precursor to an individual's transition from knowledge to action, there are numerous theories and models that posit a variety of factors to explain the adoption [or not] of health risk prevention behaviours. Concomitantly, it must be acknowledged that theories such as these do not capture or model the complexity of behavioural change in the context of health and wellbeing. If it were a simple equation (e.g. increased knowledge of health risk = behavioural change), then nearly everyone would lead healthy lifestyles, they would protect themselves against health risks, and many illnesses would be non-existent. However, it is not as simple as a linear or causal relationship and there are many factors that affect health behaviour. For example, Marcu et al. (2013) and Beaujean et al. (2013) report that individuals don't comply with tick bite prevention recommendations because they interfere with their enjoyment of the outdoors (e.g., they refuse to wear long clothes on a hot day), they believe the risk of tick bites is low (perceived susceptibility), they do not believe that the recommendations are effective (e.g., insect repellent does not always prevent bites), and they are not confident in their ability to identify a tick or a tick bite. In this case, an improved understanding of the individuals and segments at risk for Lyme and other tick-borne diseases as well as the factors that do or do not influence their behaviours is needed to inform the development of targeted and tailored public health interventions (Bayles et al., 2013; Beaujean et al., 2013; Mowbray et al., 2012).

4. Tourism management implications and recommendations

The epidemiological evidence is strongly indicative of a cause-effect relationship between tick exposure and Lyme disease infection. Although the science is embryonic when it comes to the relationship between knowledge, personal protection behaviour, and Lyme disease risk, it certainly suggests that these factors can act as risk moderators and mediators. Short of major changes in tick ecology, vaccine availability, tick control, and human behaviour, predictive models suggest that Lyme disease will continue to be a public health threat in an increasing number of areas around the world. When we examine this issue through a tourism lens, it is clear that Lyme disease is posing a real and growing threat to both supply and demand in endemic and emergent areas of the world.

Decisions regarding the primary prevention of vector-borne diseases such as Lyme disease are as a matter of course, made at the national, state, or regional level and do not involve tourism industry stakeholders but should. In the past, a plethora of methods for large-scale Lyme disease prevention including vaccines, biological and chemical tick control methods have been adopted by government agencies at a variety of scales (Garcia-Alvarez et al., 2013). In 1998, the United States Federal Drug Administration (FDA) approved the LYMErix™ vaccine and the CDC Advisory Committee on Immunization Practices (ACIP) recommended vaccination for those living in high risk areas (Nigrovic & Thompson, 2007). Although it was shown to reduce new infections in vaccinated adults by 76 percent, the manufacturer voluntarily withdrew the product from the market in 2002 amidst reports of side-effects, a government investigation, a class-action lawsuit, negative media coverage, and declining sales (Nigrovic & Thompson, 2007). In the absence of a human vaccine, a variety of chemicals have been used to reduce the overall tick population but the effect has proven short-lived, their use impractical on a large-scale basis, and chemical resistance has been observed in tick species (George, 2006). Wildlife management has been explored as a less-toxic alternative but attempts to limit the primary host population through hunting, landscape modifications, and movement restrictions (e.g. fencing) have produced mixed results and they too are impractical on a large-scale basis (Heymann, 2008; Piesman & Eisen, 2008). While these interventions may have blunted the tick population and pathogen lifecycle, “they have clearly not been sufficient to lower the number of [Lyme] cases, and the epidemic continues to gain momentum” (Hayes & Piesman, 2003: 2424). Given that these efforts have not yet achieved the desired end, Willadsen (2006: 161) argues that “The achievement of the full potential of vaccination, the application of biocontrol agents and the coordinated management of the existing technologies all pose challenging research problems.” With an eye to the future, scholars are expressing hope that the development and application of new scientific tools and technologies (i.e. molecular techniques) will have the capacity to revolutionize tick control methods and policies into the future or better yet, they will manifest an effective human vaccine (Garcia-Alvarez et al., 2013; Sonenshine, Kocan, & de la Fuente, 2006; Willadsen, 2006).

In the absence of such a vaccine or other suitable prophylactic and effective tick control methods, Piesman and Eisen (2008: 336) argue that Lyme disease education is the single most important area in which public health agencies, employers, and other stakeholders can invest to reduce the burden of infection. They argue that the next logical step in prevention is to “Ensure ready access to objective information empowering the individuals de facto responsible for control of ticks and tick-borne diseases to make rational and informed decisions regarding their personal risk of exposure to tick-borne pathogens and to take appropriate actions to mitigate risk of tick bites and pathogen exposure.” In the United States for example, the CDC has an active tick-borne disease prevention program with a dedicated focus on Lyme disease and many state health agencies have developed similar public health education programs. However, they fail to account for the unique characteristics of tourists who may not be familiar with the local area and health risks, and they are unlikely to know where to seek local health risk information. The implications are such that the tourism industry and the tourists upon which it depends are left vulnerable to the real and perceived risk of Lyme disease.

Perhaps it is best that disease prevention be left in the hands of public health experts, but this does not negate the role that tourism bodies can play, in partnership with public health and other organizations, to address the growing Lyme disease problem in many parts of the world. It is recommended that tourism industry associations, destination management organizations (DMO), and convention and visitors bureaus (CVB) for example, represent the industry's unique interests, characteristics, needs, and concerns in the public health decision-making forum at national, state, and regional levels (e.g. form a task group). And it is important that these same industry stakeholders assume a leadership role in the dissemination and operationalization of any public health interventions that affect those providing travel and tourism services and those consuming them.

When considering the day-to-day management of tourism in high-risk destinations and emergent areas for Lyme disease, Parsons (1996) and Pennington-Gray et al. (2009) recommend that managers take a proactive rather than reactive management approach to potential health threats so that they can mitigate the risks and deal with the threat more effectively. Ritchie (2004) and Pennington-Gray, Thapa, Kyriaki, Cahyanto, and McLaughlin (2011) recommend the development of a multi-phase management plan to help destinations and/or attractions, accommodations, and other servicing businesses avoid or limit the severity of the threat's impact on supply and demand. The plan should address: (1) how to prevent the threat, (2) what to do in the event of, and (3) how to recover. In the later cases, generalizable tourism crisis management guidance is available in the literature (e.g. Faulkner, 2001; Ritchie, 2004; Young & Montgomery, 1997).

In the specific Lyme disease context, it is strongly recommended that tourism managers become informed and take action to protect visitors and employees from the risk of acquiring Lyme and other tick-borne diseases. Public health authorities should be consulted about the risks for tick-borne disease in the area and any potential “hotspots” for high tick activity and disease risk should be identified and marked. For example, brochures could be provided to visitors upon entry into state or national parks and warning signs could be posted at trail heads, picnic areas, or other high human activity areas where the risk for a tick encounter exists. Similarly, park managers could provide brochures and workshops to employees so that they can be made aware of the risks and the ways to protect themselves and park visitors. In endemic areas, travellers arriving by air or ferry or other could be provided with an informative pamphlet in arrival, departure, or visitors centres. Public health authorities and local pest management experts should be consulted when making tick control decisions at tourism attractions so as to avoid costly, illegal, or harmful mistakes. Where it is feasible or appropriate, tourism managers should seek out a biological tick control expert to recommend strategies for tick and/or wildlife control (e.g. deer fencing). For example, removing leaf litter and cutting back tall grass and brush in high human activity areas is a simple and low cost way to reduce ticks and tick encounters in tourism destinations.

It is also recommended that tourism management stakeholders seek out educational materials from public health authorities and make them available to employees and visitors. In the United States, the CDC has a free toolkit that includes downloadable fact sheets in English, Spanish, and Portuguese and pamphlets and trail signs can be ordered free of charge (http://www.cdc.gov/lyme/toolkit/index.html). In Michigan, the public health authority has made available a downloadable fact sheet entitled “Preventing Lyme disease in recreational camp settings” that provides recommendations for staff and visitor protection (http://www.michigan.gov/documents/emergingdiseases/camp_guidelines_321958_7.pdf). The California Department of Public Health has developed an interactive website to provide information about infected ticks as part of its statewide vector-borne disease surveillance program. The data on the map represents ticks collected and tested by the California Department of Public Health as well as vector control and public health agencies in the state (http://cdphgis.maps.arcgis.com/apps/SocialMedia/

index.html?appid=8d99fb1135d1424f9d8a8711acb7d459). This website is a useful model for developing publicly available risk maps for tick-borne diseases in other areas of the world. Tourism managers can provide invaluable information to surveillance programs such as the one in California by reporting tick encounters and providing ticks collected in and around tourism attractions to the local authorities for testing. This information is valuable because it can inform public health authorities about emerging outbreaks and it is a pragmatic way in which the tourism industry can take an active role in the monitoring of tick-borne diseases on a local-to-global scale.

The World Health Organization (2012) published the *International Travel and Health* book and it contains authoritative information about the geographical distribution, risk for travellers, and recommended precautions for Lyme disease and a myriad of other health risks (http://www.who.int/ith/en/). On a biannual basis, the CDC (CDC & Brunette, 2013) publishes *Health Information for International Travel* or the "Yellow Book" as it is commonly known (http://www.cdc.gov/features/yellowbook). While it is written primarily for health practitioners, international corporations, volunteer organizations, travel industry professionals, and travellers often refer to this book for recommendations for addressing health risks and international travel. Making the aforementioned resources available to employees and visitors by providing copies onsite or sharing the web links to these multimedia resources would enable access to authoritative information before, during, and after travel. Tourism managers can use existent resources such as the ones mentioned and/or they can invest in the development of their own communication plan and tools so as to account for the unique risks, visitor or employee demographics, or other conditions specific to their site. For example, Rocky Mountain National Park developed a downloadable brochure that details the health risks and unique ecology associated with ticks in the park (http://www.nps.gov/romo/planyourvisit/upload/ticks_2008.pdf). It is also recommended that an occupational risk workshop or training module be offered so as to improve employee knowledge of the risks and the action they can take to prevent the disease and educate visitors.

It must be stressed that regardless of the intervention, whether it be tick control or educational programs, tourism management stakeholders should consult and collaborate with travel health experts and public health authorities if we are to make any gains in tackling this health and safety issue. There is a role for tourism and it is recommended that tourism stakeholders partner with appropriate agencies and organizations, become active in local surveillance efforts, and co-develop educational or other interventions. This breadth of expertise and perspective is required for addressing and yielding positive results with respect to the complexity that is Lyme and tick-borne disease control.

5. Conclusions and future research needs

This paper has critically reviewed and synthesized the literature concerned with Lyme disease and three human risk factors have been identified. Exposure was confirmed to be the only prognostic factor for infection while knowledge and personal protection behaviour were identified as mediating risk factors. The review noted that the research concerned with these risk factors is lean albeit evolving and there is much to be learned from all relevant scientific domains from anthropology, to entomology, to pathology, to zoology. By extension, there is a lot of work required to translate science into real-world solutions. Piesman and Eisen (2008: 336) state this future research need succinctly: "Academic research on tick-borne diseases must be brought into the real world and effective methods for the prevention of tick-borne disease must be made cheap, easy, and safe." Research funding is best spent developing a vaccine but until such a vaccine is deemed safe for widespread use or an effective tick control method is developed, research concerned with the aforementioned risk factors is needed to better inform public health interventions targeting the minutiae of human behaviour.

In the tourism context, we must first expand beyond our geographical understanding so that we can better understand the spatial reach of Lyme disease and destinations at-risk. Risk maps are commonly used as a decision support tool by public health agencies, the medical community, and those who are tasked with protecting individual or community health. While the CDC (2010) makes an updated national risk map (Based on surveillance data) available every few years, there is much for the tourism industry to learn from the fine-scale surveillance and mapping of disease epidemiology, tick populations, human behaviour, and the environment. As previously stated, tourism managers can play an active role in disease surveillance by monitoring and reporting what is happening on the ground at tourism attractions and destinations. In the global context, understanding has been constrained by research primarily focused on North America and Europe. Future research should focus on other endemic and emergent areas of the world. Specific attention should be paid to destinations where nature-based activities are the primary touristic attraction as the potential impact of Lyme and other tick-borne diseases could be significant for destination sustainability.

Research is also needed to better document and predict the scale and scope of the Lyme disease risk associated with human activities and behaviours. In completing this review, it is apparent that behavioural research is an important but inadequately studied aspect of Lyme disease prevention. Activity-based risk research has focused on outdoor activities generally and outdoor work and outdoor recreation specifically. Future research should focus on identifying differences, if at all, between different kinds of outdoor work and/or outdoor recreation activities. Insight into these differences would certainly help tourism managers categorize the risks and plan accordingly. Decisions concerning personal protection against Lyme disease are made at the individual level yet little is known about perceptions of risk and other potential catalysts for protective behaviour. Future research should focus on identifying unknown factors and better understanding known factors as well as their influence on an individual's choice to engage in protective behaviour. In the tourism context, the catalyst(s) may be different between the general population, tourists, and outdoor workers and this certainly requires research investments if the industry is to plan a response.

Future research should also be concerned with improving our very limited understanding of the impacts that Lyme disease is having on the tourism industry. Based on this review, we can surmise that it is having an impact on employee health, travel choices, and the economic sustainability of tourism in endemic areas but empirical research is needed to identify the scale and scope of past, present, and future impacts. Theoretically driven research is needed to improve our knowledge of the relationships between public health, tourism, and the natural environment so that tourism management stakeholders can be empowered to be active agents in evolving and transdisciplinary efforts to prevent, manage, and recover from Lyme disease outbreaks.

References

Abbott, A. (2006). Lyme disease: uphill struggle. *Nature, 439*, 524–525.
Adelson, M. E., Rao, R. V. S., Tilton, R. C., Cabets, K., Eskow, E., Fein, L., et al. (2004). Prevalence of *Borrelia burgdorferi*, *Bartonella* spp., *Babesia microti*, and *Anaplasma phagocytophila* in *Ixodes scapularis* ticks collected in Northern New Jersey. *Journal of Clinical Microbiology, 42*(6), 2799–2801.

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes, 50*, 179–211.

Ajzen, I. (2002). Perceived behavioural control, self-efficacy, locus of control, and the theory of planned behaviour. *Journal of Applied Social Psychology, 32*, 665–683.

Allan, B., Keesing, F., & Ostfield, R. (2003). Effect of forest fragmentation on Lyme disease risk. *Conservation Biology, 17*(1), 267–272.

Barbour, A., Maupin, G., Teltow, G., Carter, C., & Piesman, J. (1996). Identification of an uncultivable Borrelia species in the hard tick Amblyomma americanum: possible agent of a Lyme disease-like illness. *Journal of Infectious Diseases, 173*(2), 403–409.

Bartosik, K., Sitarz, M., Szymańska, J., & Buczek, A. (2011). Tick-bites on humans in the agricultural and recreational areas in south-eastern Poland. *Annals of Agricultural and Environmental Medicine, 18*(1), 151–157.

Bayles, B., Evans, G., & Allan, B. (2013). Knowledge and prevention of tick-borne diseases vary across an urban-to-rural human land-use gradient. *Ticks and Tick-Borne Diseases, 4*(4), 352–358.

Beaujean, D., Bults, M., van Steenbergen, J., & Voeten, H. (2013). Study on public perceptions and protective behaviours regarding Lyme disease among the general public in the Netherlands: implications for prevention programs. *BMC Public Health, 13*, 225–236.

Birnbrauer, K., Pennington-Gray, L., & Donohoe, H. (2013). Dengue fever knowledge, attitudes and practices among Bahamians and U.S. tourists. *British Global and Travel Health Association Journal, 22*(Winter), 56–60.

Bochnickova, M., & Szilagyiova, M. (2011). Lyme borreliosis – risk of occupational infection. *Clinic of Infectology and Travel Medicine, 11*(2), 40–44.

Bowen, G., Schulze, T., Hayne, C., & Parkin, W. (1984). A focus of Lyme disease in Monmouth County, New Jersey. *American Journal of Epidemiology, 120*, 387–394.

Brewer, N., Weinstein, N., Cuite, C., & Herrington, J. (2004). Risk perceptions and their relation to risk behaviour. *Annals of Behavioural Medicine, 27*(2), 125–130.

Burgdorfer, W. (1984). Discovery of the Lyme disease spirochete and its relation to tick vectors. *Yale Journal of Biology and Medicine, 57*(4), 515–520.

van Charante, A. M., Groen, J., Mulder, P., Rijpkema, S., & Osterhaus, A. (1998). Occupational risks of zoonotic infections in Dutch forestry workers and muskrat catchers. *European Journal of Epidemiology, 14*(2), 109–116.

Choi, H. W., Breman, J. G., Teutsch, S. M., Liu, S., Hightower, A. W., & Sexton, J. D. (1995). The effectiveness of insecticide-impregnated bed nets in reducing cases of malaria infection: a meta-analysis of published results. *The American Journal of Tropical Medicine and Hygiene, 52*(5), 377–382.

Ciesielski, C., Markowitz, L., Horsley, R., Hightower, A., Russell, H., & Broome, C. (1989). Lyme disease surveillance in the United States, 1983–1986. *Clinical Infectious Disease, 11*(6), 1435–1441.

Cisak, E., Wójcik-Fatla, A., Zając, V., Sroka, J., & Dutkiewicz, J. (2012). Risk of Lyme disease at various sites and workplaces of forestry workers in eastern Poland. *Annals of Agricultural and Environmental Medicine, 19*(3), 465–468.

Clark, K. (2004). Borrelia species in host-seeking ticks and small mammals in northern Florida. *Journal of Clinical Microbiology, 42*(11), 5076–5086.

Clark, K., Leydet, B., & Hartman, S. (2013). Lyme Borreliosis in human patients in Florida and Georgia, USA. *International Journal of Medical Sciences, 10*(7), 915–931.

Corapi, K., White, M., Phillips, C., Daltroy, L., Shadick, N., & Liang, M. (2007). Strategies for primary and secondary prevention of Lyme disease. *Nature Clinical Practice Rheumatology, 3*(1), 20–25.

Curioni, V., Cerquetella, S., Scuppa, P., Pasqualini, L., Beninati, T, & Fava, G. (2004). Lyme disease and babesiosis: preliminary findings on the transmission risk in highly frequented areas of the Monti Sibillini National Park (Central Italy). *Vector Borne and Zoonotic Diseases, 4*(3), 214–220.

Daltroy, L., Phillips, C., Lew, R., Wright, E., Shadick, N., & Liang, M. (2007). A controlled trial of a novel primary prevention program for Lyme disease and other tick-borne illnesses. *Health Education and Behaviour, 34*(3), 531–542.

Daniel, M., Danielová, V., Kříž, B., Jirsa, A., & Nožička, J. (2003). Shift of the tick Ixodes ricinus and tick-borne encephalitis to higher altitudes in central Europe. *European Journal of Clinical Microbiology & Infectious Diseases, 22*(5), 327–328.

Daniels, T. J., Falco, R. C., Schwartz, I., Varde, S., & Robbins, R. G. E. (1997). Deer ticks (*Ixodes scapularis*) and the agents of Lyme disease and human granulocytic *Ehrlichiosis* in a New York City park. *Emerging Infectious Diseases, 3*(3), 353–355.

Daugschies, A. (2001). Importation of parasites by tourism and animal trading. *Deutsche Tierärztliche Wochenschrift, 108*(8), 348–352.

Diuk-Wasser, M., Gatewood Hoen, A., Cislo, P., Brinkerhoff, R., Hamer, S., Rowland, M., et al. (2012). Human risk of infection with *Borrelia burgdorferi*, the Lyme disease agent, in eastern United States. *American Journal of Tropical Medicine and Hygiene, 86*(2), 320–327.

Diuk-Wasser, M. A., Gatewood, A. G., Cortinas, M. R., Yaremych-Hamer, S., Tsao, J., Kitron, U., et al. (2006). Spatiotemporal patterns of host-seeking *Ixodes scapularis* nymphs (Acari: Ixodidae) in the United States. *Journal of Medical Entomology, 43*(2), 166–176.

Dixon, P., Lee, B., Muehlenbeck, T., Rimmer, M., Rose, A., & Verikios, G. (2010). Effects on the U.S. of an H1N1 epidemic: analysis with a quarterly CGE model. *Journal of Homeland Security and Emergency Management, 7*(1), 1547–7355.

Due, C., Fox, W., Medlock, J. M., Pietzsch, M., & Logan, J. G. (2013). Tick bite prevention and tick removal. *BMJ: British Medical Journal, 347*, 7123. http://dx.doi.org/10.1136/bmj.f7123.

Dye, C. (2003). Epidemiology. Modeling the SARS epidemic. *Science, 300*(5627), 1884–1885.

Estrada-Peña, A. (2003). The relationships between habitat topology, critical scales of connectivity and tick abundance Ixodes ricinus in a heterogeneous landscape in northern Spain. *Ecography, 26*, 661–671.

Falco, R., & Fish, D. (1989). Potential for exposure to tick bites in recreational parks in a Lyme disease endemic area. *American Journal of Public Health, 79*(1), 12–15.

Faulkner, B. (2001). Towards a framework for tourism disaster management. *Tourism Management, 22*(2), 135–147.

Finch, C., Al-Damluji, M. S., Krause, P. J., Niccolai, L., Steeves, T., O'Keefe, C. F., et al. (2014). Integrated assessment of behavioural and environmental risk factors for Lyme disease infection on Block Island, Rhode Island. *PLOS ONE, 9*(1), e84758. http://dx.doi.org/10.1371/journal.pone.0084758.

Fish, D. (1995). Environmental risk and prevention of Lyme disease. *American Journal of Medicine, 98*, 4A–2S.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behaviour: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fox, N. (2009). Tick-borne diseases: an evaluation of a Lyme disease prevention education program for eight, nine, and ten year olds. *Dissertation Abstracts International Section A: Humanities and Social Sciences, 69*, 4635.

Franke, J., Hildebrandt, A., Meier, F., Straube, E., & Dorn, W. (2011). Prevalence of Lyme disease agents and several emerging pathogens in questing ticks from the German Baltic coast. *Journal of Medical Entomology, 48*(2), 441–444.

Garcia-Alvarez, L., Palomar, A., & Oteo, J. (2013). Prevention and prophylaxis of tick bites and tick-borne related diseases. *American Journal of Infectious Diseases, 9*(3), 104–116.

George, J. (2006). Present and future technologies for tick control. *Annals of the New York Academy of Sciences, 916*(1), 583–588.

Glanz, K., Rimer, B., & Viswanath, K. (Eds.). (2008). *Health behaviour and health education: Theory, Research, and Practice* (4th ed.). San Francisco, CA: John Wiley & Sons, Inc.

Glass, G., Schwartz, B., Morgan, M., Johnson, D., Noy, P., & Israel, E. (1995). Environmental risk factors for Lyme disease identified with geographic information systems. *American Journal of Public Health, 85*(7), 944–948.

Goldstein, M., Schwartz, B., Friedmann, C., Maccarillo, B., Borbi, M., & Tuccillo, R. (1990). Lyme disease in New Jersey outdoor workers: a statewide survey of seroprevalence and tick exposure. *American Journal of Public Health, 80*(10), 1225–1229.

Goodgame, R. (2006). Norovirus gastroenteritis. *Current Gastroenterology Reports, 8*(5), 401–408.

Gould, L., Nelson, R., Griffith, K., Hayes, E., Piesman, J., Mead, P., et al. (2008). Knowledge, attitudes, and behaviours regarding Lyme disease prevention among Connecticut residents, 1999–2004. *Vector-Borne and Zoonotic Diseases, 8*(6), 769–776.

Gray, J., Kahl, O., Robertson, J., Daniel, M., Estrada-Pena, A., Gettinby, G., et al. (1998). Lyme borreliosis habitat assessment. *Zentralblatt für Bakteriologie, 287*(3), 211–228.

Grenfell, B., & Harwood, J. (1997). (Meta)population dynamics of infectious diseases. *Trends in Ecology and Evolution, 12*(10), 395–399.

Guerra, M., Walker, E., Jones, C., Paskewitz, S., Cortinas, M. R., Stancil, A., et al. (2002). Predicting the risk of Lyme disease: habitat suitability for *Ixodes scapularis* in the north central United States. *Emerging Infectious Diseases, 8*(3), 289.

Guy, E., Bateman, D., Martyn, C., Heckels, J., & Lawton, N. (1989). Lyme disease: prevalence and clinical importance of Borrelia burgdorferi specific IgG in forestry workers. *Lancet, 1*(8636), 484–485.

Hall, M. C. (2006). Tourism, disease and global environmental change: the fourth transition?. In S. Gössling, & C. M. Hall (Eds.), *Tourism and global environmental change: Ecological, social, economic and political interrelationships* (Vol. 4, pp. 159–179) New York: Routledge Taylor & Francis.

Hall, A., Vinjé, J., Lopman, B., Park, G. W., Yen, C., Gregoricus, N., et al. (2011). Updated norovirus outbreak management and disease prevention guidelines. US Department of Health and Human Services, Centers for Disease Control and Prevention. *Morbidity and Mortality Weekly Report (MMWR), 60*(RR03), 1–15.

Hallman, W., Weinstein, N., Kadakia, S., & Chess, C. (1995). Precautions taken against Lyme disease at three recreational parks in endemic areas of New Jersey. *Environment & Behaviour, 27*(4), 437–453.

Hanson, M., & Edelman, R. (2003). Progress and controversy surrounding vaccines against Lyme disease. *Expert Reviews of Vaccines, 2*(5), 683–703.

Harrison, J., Mullen, P., & Green, L. (1992). A meta-analysis of studies of the health belief model with adults. *Health Education Research, 7*(1), 107–116.

Harrison, B., Rayburn, W., Toliver, M., Powell, E., Engber, B., Durden, L., et al. (2010). Recent discovery of widespread Ixodes affinis (Acari: Ixodidae) distribution in North Carolina with implications for Lyme disease studies. *Journal of Vector Ecology, 35*(1), 174–179.

Hayes, E. (2010). Looking the other way: preventing vector-borne disease among travelers to the United States. *Travel Medicine and Infectious Disease, 8*, 277–284.

Hayes, E., & Piesman, J. (2003). How can we prevent Lyme disease? *The New England Journal of Medicine, 348*, 2424–2430.

Herrington, J. (2004). Risk perceptions regarding ticks and Lyme disease: a national survey. *American Journal of Preventive Medicine, 26*(2), 135–140.

Heymann, D. (Ed.). (2008). *Control of communicable diseases manual*. Washington, DC: American Public Health Association.

Holzer, B. (2005). Tick borne diseases. *Ther Umsch, 62*(11), 757–763.

Horowitz, H., Aguero-Rosenfeld, M., Holmgren, D., McKenna, D, Schwartz, I., Cox, M., et al. (2013). Lyme disease and human granulocytic anaplasmosis coinfection: impact of case definition on coinfection rates and illness severity. *Clinical Infectious Disease, 56*(1), 93–99.

Jameson, L., & Medlock, J. (2011). Tick surveillance in Great Britain. *Vector Borne and Zoonotic Diseases, 11*(4), 403–412.

Janz, N. K., & Becker, M. J. (1984). The health belief model: a decade later. *Health Education and Behaviour, 11*(1), 1–47.

Jenks, N., & Trapasso, J. (2005). Lyme risk for immigrants to the United States: the role of an educational tool. *Journal of Travel Medicine, 12*(3), 157–160.

Jonas, A., Mansfeld, Y., Paz, S., & Potasman, I. (2011). Determinants of health risk perception among low-risk-taking tourists traveling to developing countries. *Journal of Travel Research, 50*(l 1), 87–99.

Kahl, O., & Radda, A. (1988). Occurrence of tick-borne encephalitis (TBE) virus in Berlin (West). *Zentralblatt für Bakteriologie, Mikrobiologie und Hygiene. Series A: Medical Microbiology, Infectious Diseases, Virology, Parasitology, 268*(4), 482–486.

Kelly-Hope, L., Purdie, D., & Kay, B. (2002). Risk of mosquito-borne epidemic polyarthritis disease among international visitors to Queensland, Australia. *Journal of Travel Medicine, 9*(4), 211–213.

Kuiper, H., De Jongh, B. M., Nauta, A. P., Houweling, H., Wiessing, L. G., et al. (1991). Lyme borreliosis in Dutch forestry workers. *Journal of Infection, 23*(3), 279–286.

Kollaritsch, H., Chmelík, V., Dontsenko, I., Grzeszczuk, A., Kondrusik, M., Usonis, V., et al. (2011). The current perspective on tick-borne encephalitis awareness and prevention in six Central and Eastern European countries: report from a meeting of experts convened to discuss TBE in their region. *Vaccine, 29*(28), 4556–4564.

Kozak, M., Crotts, J., & Law, R. (2007). The impact of the perception of risk on international travelers. *International Journal of Tourism Research, 9*(4), 233–242.

Kuo, H., Chen, C., Tseng, W., Ju, L., & Huang, B. (2008). Assessing impacts of SARS and Avian Flu on international tourism demand to Asia. *Tourism Management, 29*(5), 917–928.

Lane, R., Kucera, T., Barrett, R., Mun, J., Wu, C, & Smith, V. (2006). Wild Turkey (*Meleagris gallopavo*) as a host of ixodid ticks, lice, and Lyme disease spirochetes (*Borrelia burgdorferi* sensu lato) in California state parks. *Journal of Wildlife Diseases, 42*(4), 759–771.

Leigh, J. P. (2011). Economic Burden of occupational injury and illness in the United States. *Milbank Quarterly, 89*(4), 728–772.

Madden, T. J., Ellen, P. S., & Ajzen, I. (1992). A comparison of the theory of planned behaviour and the theory of reasoned action. *Personality and Social Psychology Bulletin, 18*(1), 3–9.

Maes, E., Lecomte, P., & Ray, N. (1999). A cost-of-illness study of Lyme disease in the United States. *Clinical Therapeutics, 20*(5), 993–1008.

Magnarelli, L. (2009). Global importance of ticks and associated infectious disease agents. *Clinical Microbiology Newsletter, 31*(5), 33–37.

Maher, N., Akerblom, J., Karlson, J., Maher, C., Cantor, F., Soliva, S., et al. (2004). A Lyme disease education program changes knowledge, attitudes and behaviours in elementary school children living in an endemic area. *Arthritis & Rheumatology, 50*, S77.

Maher, T., Nicholson, M., Donnelly, E., & Matyas, B. (1996). Entomologic index for human risk of Lyme disease. *American Journal of Epidemiology, 144*(11), 1066–1069.

Malouin, R., Winch, P., Leontsini, E., Glass, G., Simon, D., Hayes, E., et al. (2003). Longitudinal evaluation of an educational intervention for preventing tick bites in an area with endemic Lyme disease in Baltimore County, Maryland. *American Journal of Epidemiology, 157*(11), 1039–1051.

Marcu, A., Barnett, J., Uzzell, D., Vasileiou, K., & Susan, O. (2013). Experience of Lyme disease and preferences for precautions: a cross-sectional survey of UK patients. *BMC Public Health, 13*(1), 481–488.

Mather, T., & Mather, M. (1990). Intrinsic competence of three Ixodid ticks (Acari) as vectors of the Lyme disease spirochete. *Journal of Medical Entomology, 27*(4), 646–650.

McKenna, D., Faustini, Y., Nowakowski, J., & Wormser, G. (2004). Factors influencing the utilization of Lyme disease-prevention behaviours in a high-risk population. *Journal of the American Academy of Nurse Practitioners, 16*(1), 24–30.

Morshed, M., Scott, J., Fernando, K., Mann, R., & Durden, L. (2003). Lyme disease spirochete, *Borrelia burgdorferi* endemic at epicenterin Rondeau Provincial Park, Ontario. *Journal of Medical Entomology, 40*(1), 91–94.

Mowbray, F., Amlôt, R., & Rubin, G. J. (2012). Ticking all the boxes? A systematic review of education and communication interventions to prevent tick-borne disease. *Vector Borne Zoonotic Diseases, 12*(9), 817–825. http://dx.doi.org/10.1089/vbz.2011.0774.

Motiejunas, L., Bunikis, J., Barbour, A., & Sadziene, A. (1994). Lyme borreliosis in Lithuania. *Scandinavian Journal of Infectious Diseases, 26*(2), 149–155.

Nakama, H., Muramatsu, K., Uchikawa, K., & Yamagishi, T. (1994). Possibility of Lyme disease as an occupational disease — seroepidemiological study of regional residents and forestry workers. *Asia-Pacific Journal of Public Health, 7*(4), 214–217.

Nakao, M., Miyamoto, K., & Fukunaga, M. (1994). Lyme disease spirochetes in Japan: enzootic transmission cycles in birds, rodents, and ixodes persulcatus ticks. *The Journal of Infectious Diseases, 170*(4), 878–882. http://dx.doi.org/10.1093/infdis/170.4.878.

Nigrovic, L. E., & Thompson, K. M. (2007). Editorial review. The Lyme vaccine: a cautionary tale. *Epidemiology and Infection, 135*(1), 9–10.

Ogden, N., Maarouf, A., Barker, I., Bigras-Poulin, M., Lindsay, L., Morshed, M., et al. (2008). Risk maps for range expansion of the Lyme disease vector, Ixodes scapularis, in Canada now and with climate change. *International Journal of Health Geographics, 7*, 24–39. http://dx.doi.org/10.1186/1476-072X-7-24.

Ostfeld, R., Schauber, E., Canham, C., Keesing, F., Jones, C., & Wolff, J. (2001). Effects of acorn production and mouse abundance on abundance and *Borrelia burgdorferi* infection prevalence of nymphal *Ixodes scapularis* ticks. *Vector Borne and Zoonotic Diseases, 1*(1), 55–63.

Parsons, W. (1996). Crisis management. *Career Development International, 1*(5), 26–28.

Patey, O. (2007). Lyme disease: prophylaxis after tick bite. *Medicine et Maladies Infectieuses, 37*(7–8), 446–455.

Pennington-Gray, L., Cahyanto, I., Thapa, B., McLaughlin, E., Willming, C., & Blair, S. (2009). Destination management organizations and tourism crisis management plans in Florida. *Tourism Review International, 13*(4), 247–261.

Pennington-Gray, L., Thapa, B., Kyriaki, K., Cahyanto, I., & McLaughlin, E. (2011). Crisis planning and preparedness in the United States Tourism Industry. *Cornell Hospitality Quarterly, 52*(3), 312–320.

Piacentino, J., & Schwartz, B. (2002). Occupational risk of Lyme disease: an epidemiological review. *Occupational and Environmental Medicine, 59*(2), 75–84.

Piesman, J., Clark, K., Dolan, M., Happ, C., & Burkot, T. (1999). Geographic survey of vector ticks (*Ixodes scapularis* and *Ixodes pacificus*) for infection with the Lyme disease spirochete, Borrelia burgdorferi. *Journal of Vector Ecology, 24*(1), 91–98.

Piesman, J., & Eisen, L. (2008). Prevention of tick-borne diseases. *Annual Review Entomolology, 53*, 323–343.

Piesman, J., & Sinsky, R. (1988). Ability of *Ixodes scapularis*, dermacentor variabilis, and *Amblyomma americanum* (Acari: Ixodidae) to acquire, maintain, and transmit Lyme disease spirochetes (*Borrelia burgdorferi*). *Journal of Medical Entomology, 25*(5), 336–339.

Pine, R., & McKercher, B. (2004). The impact of SARS on Hong Kong's tourism industry. *International Journal of Contemporary Hospitality Management, 16*(2), 139–143.

Poland, G. (2001). Prevention of Lyme disease: a review of the evidence. *Mayo Clinic Proceedings, 76*, 713–724.

Qui, W., Dykhuizen, D., Acosta, M., & Luft, B. (2002). Geographic uniformity of the Lyme disease spirochete (*Borrelia burgdorferi*) and its shared history with tick vector (*Ixodes scapularis*) in the Northeastern United States. *Genetics, 160*(3), 833–849.

Quine, C., Barnett, J., Dobson, A., Marcu, A., Marzano, M., Moseley, D., et al. (2011). Frameworks for risk communication and disease management: the case of Lyme disease and countryside users. *Philosophical Transactions of the Royal Society of Biological Sciences, 366*(1573), 2010–2022.

Raoult, D., Fournier, P., Fenollar, F., Jensenius, M., Prioe, T., de Pina, J., et al. (2001). Rickettsia africae, a tick-borne pathogen in travelers to sub-Saharan Africa. *New England Journal of Medicine, 344*(20), 1504–1510.

Rees, D., & Axford, J. (1994). Evidence for Lyme disease in urban park workers: a potential new health hazard for city inhabitants. *British Journal of Rheumatology, 33*, 123–128.

Renganathan, E., Parks, W., Lloyd, L., Nathan, M. B., Hosein, E., Odugleh, A., et al. (2003). Towards sustaining behavioural impact in dengue prevention and control. *World Health Organization Dengue Bulletin, 27*, 6–12.

Ritchie, B. (2004). Chaos, crisis and disasters: a strategic approach to crisis management in the tourism industry. *Tourism Management, 25*, 669–683.

Rizzolli, A., Hauffe, H., Vourc'h, G., Neteler, M., & Rosa, R. (2011). Lyme borreliosis in Europe. *Eurosurveillance, 16*(27), 19906–19914.

Rosenstock, I. M. (1974). The health belief model and preventative health behaviour. *Health Education and Behaviour, 2*(4), 354–386.

Schulze, T., Jordan, R., & Hung, R. (1995). Suppression of subadult *Ixodes scapularis* (Acari: Ixodidae) following removal of leaf litter. *Journal of Medical Entomology, 32*, 730–733.

Schulze, T. L., Jordan, R. A., Schulze, C. J., Mixson, T., & Papero, M. (2005). Relative encounter frequencies and prevalence of selected *Borrelia*, *Ehrlichia*, and *Anaplasma* infections in *Amblyomma americanum* and *Ixodes scapularis* (Acari: Ixodidae) ticks from central New Jersey. *Journal of Medical Entomology, 42*(3), 450–456.

Schuster, J., Tantcheva-Poor, I., Wickenhauser, C., Chemnitz, J. M., Hunzelmann, N., Krieg, T., et al. (2008). African tick bite fever–papulovesicular exanthem with fever after staying in South Africa. *Journal der Deutschen Dermatologischen Gesellschaft, 6*(5), 379–381.

Schwartz, B., & Goldstein, M. (1990). Lyme disease in outdoor workers: risk factors, preventative measures, and tick removal methods. *American Journal of Epidemiology, 131*(5), 877–885.

Scott, J., Lee, M., Fernando, K., Jorgensen, D., Durden, L, & Morshed, M. (2008). Rapid introduction of Lyme disease spirochete, Borrelia burgdorferi sensu stricto, in *Ixodes scapularis* (Acari: Ixodidae) established at Turkey Point Provincial Park, Ontario, Canada. *Journal of Vector Ecology, 33*(1), 64–69.

Shadick, N., Daltroy, L., Phillips, C., Liang, U., & Liang, M. (1997). Determinants of tick-avoidance behaviours in an endemic area for Lyme disease. *American Journal of Preventative Medicine, 13*(4), 265–270.

Smith, P., Benach, J., White, D., Stroup, D, & Morse, D. (1988). Occupational risk of Lyme disease in endemic areas of New York State. *Annals of the New York Academy of Sciences, 539*(1), 289–301.

Smith, G., Wileyto, E., Hopkins, R., Cherry, B., & Maher, J. (2001). Risk factors for Lyme disease in Chester County, Pennsylvannia. *Public Health Reports, Supplement, 1*(116), 146–156.

Sonenshine, D., Kocan, K., & de la Fuente, J. (2006). Tick control: further thoughts on a research agenda. *Trends in Parasitology, 22*(12), 550–551.

Sönmez, S., & Graefe, A. (1998). Determining future travel behaviour from past travel experience and perceptions of risk and safety. *Journal of Travel Research, 37*(2), 171–177.

Stanchi, N., & Balague, L. (1993). Lyme disease: antibodies against Borrelia burgdorferi in farm workers in Argentina. *Revista de Saude Publica, Sao Paulo, 27*(4), 305–307.

Šumilo, D., Bormane, A., Asokliene, L., Vasilenko, V., Golovljova, I., Avsic-Zupanc, Z., et al. (2008). Socio-economic factors in the differential upsurge of tick-borne encephalitis in Central and Eastern Europe. *Reviews in Medical Virology, 18*(2), 81–95.

Thorin, C., Rigaud, E., Capek, I., André-Fontaine, G., Oster, B., Gastinger, G., et al. (2008). Seroprevalence of Lyme borreliosis and tick-borne encephalitis in workers at risk, in eastern France. *Medicine et Maladies Infectieuses, 38*(10), 533–542.

U.S. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases, Division of Vector-Borne Diseases. (2011). *Lifecycle of blacklegged ticks*. http://www.cdc.gov/lyme/transmission/blacklegged.html Accessed 10.06.13.

U.S. Centers for Disease Control and Prevention & Brunette, G.W. (2013). *CDC health information for international travel 2014*. New York: Oxford University Press.

U.S. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases, Division of Vector-Borne Diseases. (2010). *Geographic distribution: Blacklegged tick*. http://www.cdc.gov/ticks/geographic_distribution.html Accessed 10.06.13.

U.S. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases, Division of Vector-Borne Diseases. (2013a). *Lyme disease*. http://www.cdc.gov/lyme Accessed 04.07.13.

U.S. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases, Division of Vector-Borne Diseases. (2013b). *Lyme disease data*. http://www.cdc.gov/lyme/stats/index.html Accessed 14.01.14.

U.S. Department of Labor. (2014). *The business case for safety and health*. http://www.osha.gov/dcsp/products/topics/businesscase/costs.html Accessed 03.04.14.

Vaughn, M. F., Funkhouser, S. W., Lin, F. C., Fine, J., Juliano, J. J., Apperson, C. S., et al. (2014). Long-lasting permethrin impregnated uniforms: a randomized-controlled trial for tick bite prevention. *American Journal of Preventive Medicine, 46*(5), 473–480.

Willadsen, P. (2006). Tick control: thoughts on a research agenda. *Veterinary Parasitology, 138*(1), 161–168.

Werden, L., Barker, I., Bowman, J., Gonzales, E., Leighton, P., Lindsay, R., et al. (2014). Geography, deer, and host biodiversity shape the pattern of Lyme disease emergence in the Thousand Islands archipelago of Ontario, Canada. *PLoS ONE, 9*(1), e85640. http://dx.doi.org/10.1371/journal.pone.0085640.

Wielinga, P., Gaasenbeek, C., Fonville, M., de Boer, A., de Vries, A., Dimmers, W., et al. (2006). Longitudinal analysis of tick densities and *Borrelia*, *Anaplasma*, and *Ehrlichia* Infections of ixodes ricinus ticks in different habitat areas in The Netherlands. *Applied and Environmental Microbiology, 72*(12), 7594–7601.

Wilder-Smith, A. (2006). The severe acute respiratory syndrome: impact on travel and tourism. *Travel Medicine and Infectious Diseases, 4*, 53–60.

World Health Organization. (2004). *Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003*. World Health Organization. http://www.who.int/csr/sars/country/table2004_04_21/en/ Accessed 03.04.14.

World Health Organization. (2012). *International travel and health 2012*. Geneva, Switzerland: World Health Organization.

World Health Organization. (2013). *International travel and health: Lyme borreliosis (Lyme disease)*. http://www.who.int/ith/diseases/lyme/en/ Accessed 14.06.13.

World Travel and Tourism Council. (2003). *Special SARS analysis: Impact of travel and tourism (Hong Kong, China, Singapore and Vietnam reports)*. London: World Travel and Tourism Council.

Young, W., & Montgomery, R. (1997). Crisis management and its impact on destination marketing: a guide for convention and visitors bureaus. *Journal of Convention & Exhibition Management, 1*(1), 3–18.

Zeng, B., Carter, R., & De Lacy, T. (2005). Short-term perturbations and tourism effects: the case of SARS in China. *Current Issues in Tourism, 8*(4), 306–322.

Zhang, X., Meltzer, M., Peña, C., Hopkins, A, Wroth, L., & Fix, A. (2006). Economic impacts of Lyme disease. *Emerging Infectious Diseases, 12*(4), 653–660.

Holly Donohoe, Ph.D. is an Assistant Professor in the Department of Tourism, Recreation and Sport Management at the University of Florida. Central to her research are critical examinations of tourism planning, management and marketing while evaluation science and its use of select methods and techniques for risk, impact, and policy analysis are considered her realm of expertise. Current research includes projects related to vector-borne diseases and their impact on the tourism industry. Studies range from baseline studies of public awareness, the analysis of public health and tourism crisis management policy frameworks, to the assessment of occupational risk for tourism and recreation professionals in at-risk environments.

Dr. Lori Pennington-Gray is the Director of the Tourism Crisis Management Institute at the University of Florida. She received her Ph.D from Michigan State University (1999), her MS from The Pennsylvania State University (1994) and her BS from Waterloo University in Canada (1993). She has expertise in tourism marketing, planning and development, policy and crisis management. She has been involved with a number of tourism studies globally and has worked with a number of countries on tourism policy initiatives. Dr. Pennington-Gray has published more than 40 refereed articles, has brought in more than $2M in external research dollars and made over 100 presentations. Dr. Pennington-Gray teaches both undergraduate and graduate students the concepts of tourism policy, planning, marketing and crisis management.

Oghenekaro Omodior, is a doctoral student in the Department of Tourism, Recreation and Sports Management at the University of Florida. He received his undergraduate training in Medical Laboratory Sciences and a Master of Science degree in Clinical biochemistry from Olabisi Onabanjo University in Nigeria and Masters of Public Health from the University of South Carolina. Karo's research is concerned with spatial patterns and public health impacts of vector-borne and emerging infectious diseases on tourism and outdoor recreation. He is a Fellow of the Medical Laboratory Sciences Council of Nigeria and a Certified Health Education Specialist (CHES).